

Review Optimal Cooking Techniques for Vegetables to Maximise Retention of Nutrients

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Summary

This project collated scientific information on the impact of cooking on texture, flavour, colour & nutrient/phytonutrient content & bioavailability in all levied vegetables. A summary of this information is presented for each levied vegetable, and has been made available at www.veggycation.com.au/for-veg-lovers/vegetables, with an explanation of the general impact of different cooking methods on nutrients, including in canned and frozen vegetables, at <http://www.veggycation.com.au/cooking-vegetables>.

Recommended optimal cooking methods were developed for all levied vegetables, and diagrammatic representations of these were developed and are presented and also used on the website. Due to a lack of available information, a selection of Asian vegetables were cooked in a number of ways, and the Vitamin C (Ascorbic acid) was measured in cooked samples; cooking recommendations were then developed. Diagrammatic instructions for optimal cooking methods and recipes for Asian vegetables in traditional and more mainstream dishes were developed. All cooking diagrams and recipes were tested on over 600 consumers and stakeholders, for understanding and clarity. Amendments were made, and resources were added to www.veggycation.com.au as text/images and downloads.

Keywords

Vegetables; nutrients; vitamins; cooking; health; benefits; herbs; nutrition; dietary; canned vegetables; frozen vegetables.

Introduction

A previous project (VG12043) undertaken by this team established a web portal to communicate the health benefits of vegetables to stakeholders (www.veggycation.com.au). The current project extended that information to include the impact of cooking on nutrients, flavour and texture, plus addressing the impact of canning and freezing vegetables on nutrient content in response to demand from users of the website. Cooking changes the colour, texture, taste and the vitamin content of vegetables, which can impact on health benefits obtained from consuming those vegetables. Based on much scientific evidence, this project has developed a number of recommended cooking methods for the best taste and nutritional benefits from all levied vegetables.

Asian vegetables are gaining in popularity and availability, however many Australians still lack knowledge about sourcing, preparing and cooking with them. Typical Asian vegetables were cooked in a number of ways and the Vitamin C content was assayed, to provide information missing from published databases. Taking this information further, a number of how-to diagrammatic instructions for preparing and using Asian vegetables such as Daikon radish, Bitter melon, Chinese broccoli and Wombok were developed, featuring both traditional Asian and more mainstream themes.

The diagrams representing the optimal cooking methods, plus the Asian vegetable preparation and cooking instructions, were tested for understanding and clarity amongst almost 600 consumers and stakeholders. Gaps and issues were addressed, and the resources were modified and uploaded to the Veggycation® website as tools to be seen online, and to download.

It is envisaged that making this information available to industry, to other stakeholders and to the media will assist in contributing towards increased consumption of Australian-grown vegetables.

Methodology

Literature Review

We reviewed the scientific literature (last 10 years) on the impact of vegetable preparation & cooking methods on texture, flavour, colour, nutrient & phytonutrient content & bioavailability of all levied vegetables, plus the impact of other meal components (proteins, dairy, fat, salts, acids) on the bioavailability of nutrients/phytonutrients from cooked vegetables. Also included, was information on frozen and canned vegetables, where available, as this has been regularly requested. To compile nutrient data for impact of cooking on a range of vegetables different approaches were taken:

- 1) **Database collation:** Nutrient composition data for both raw and cooked vegetables from standard food composition databases were aligned to make direct comparisons. Sources: NUTTAB www.foodstandards.gov.au/science/monitoringnutrients/nutrientables/nuttab/Pages/default.aspx); New Zealand Food Composition database (<http://www.foodcomposition.co.nz/>); United States Department of Agriculture National Nutrient Database for Standard Reference (<http://ndb.nal.usda.gov/>).
- 2) **Application of Standard Retention Factors:** The nutrient composition of a cooked food may be calculated from the uncooked food by applying accredited nutrient retention factors. The USDA Table of Nutrient Retention Factors is the major source of nutrient retention data for US and any international food composition databases. There are other nutrient retention factors (e.g. Bergström 1994; Bognár 2002; McCance & Widdowson 2002) and we examined those reviewed by Bell et al. (2006). However, these are not as comprehensive as the USDA data set.
- 3) **Literature searches:** Web of Science databases were searched for scientific papers examining effect of cooking on nutrients, nutrient interactions.
- 4) More detailed searches were undertaken for **Asian vegetables** but there was very limited information and in most cases the study quality was poor.
- 5) Specific information was also gathered on the **canning and freezing** of vegetables because this is often requested via the website.

The impact of other meal components on the bioavailability of nutrients/phytonutrients from cooked vegetables was also considered.

Conversion into user-friendly information

This information was used in summary format to update the database behind www.veggycation.com.au, so that when information about each levied vegetable is presented, it includes cooking and usage recommendations.

The team then developed **optimum cooking recommendations** for most vegetables. The rationale behind this was:

- If a specific cooking method reduced the content of vitamins, present in raw vegetables at source level (10% of the RDI/serve) or good source (25% of the RDI/serve) level, **to a level below source levels, this was significant**, and this failed to become a recommended cooking method.
- If a cooking method reduced vitamin content, but **not to a level below that of source claim, this was not significant**, as it wouldn't impact on the potential health claim; thus a recommended cooking method was identified.
- Where the level of specific vitamins present in raw vegetables were already below source claim level, any cooking method would not change health claim status, thus we concluded that **any** cooking method was appropriate, however the impact on texture and flavour would be noted.
- Where the level of vitamins present in raw vegetables were already well above good source level (Vitamin A precursors in carrots, for example), and none of the cooking methods reduced them below this, or source level, we concluded that **any** cooking method was appropriate.

A table comprising specific information and identified recommended optimal cooking methods for each levied vegetable was produced (Appendix 1). This displays as a series of diagrams for recommended cooking methods on the website for each vegetable.

For example, for carrots:

Preparation & Cooking Tips: There are many benefits from eating both raw and cooked carrots regularly. Peeling doesn't have as big an impact on nutrient loss as with some other vegetables, although in some carrots, especially purple varieties, a reduction in bitterness may be noted with peeling. Carrots are one of the few vegetables that contain a good source level - well over 25% of the RDI per serve - of a vitamin, in this case Vitamin A. Actually, they contain very high levels of orange coloured beta-carotene, which is converted by our bodies into Vitamin A. Whilst some key nutrients may be reduced by cooking, others, such as Vitamin A from beta-carotene, are made more available to our bodies, and Vitamin B6 is retained well with cooking. Addition of fat in the form of butter, or oil, increases our ability to absorb fat-soluble Vitamin A-forming carotenoids. In scientific studies, boiling and other cooking methods reduced Vitamin C content below the 10% RDI per serve, but effectively increased folate to more than 10% of the RDI per serve. Potassium was reduced below 10% of the RDI per serve with boiling and cooking from frozen. Steaming retains more nutrients than boiling and produces tastier carrots. If carrots are cooked whole, then cut up, they are noticeably sweeter than if they are cut up first, as less sugars are lost during the cooking process (especially noticeable with boiling). Carrots are often used in Asian cooking, also. Canned carrots have lost 88% of their Vitamin C, and 26% of their anti-oxidant activity compared with freshly harvested carrots. Frozen carrots lose 10-36% of their carotenoid content, and up to 35% of their Vitamin C content in the blanching process which precedes commercial freezing, although there is some variability in the results from several studies on this subject. We recommend any cooking method for carrots, as the Vitamin-A forming carotenoids are present at such a high level. Try to eat a carrot, every day, for your health. The 'white blush' which sometimes appears on the surface of refrigerated carrots is a harmless discolouration resulting from moisture loss or abrasion during storage. It has nothing to do with chlorine and does not affect the taste or nutritional value of the carrots.



The complete list of recommended cooking methods for all levied vegetables also appears in a summarised form on <http://www.veggycation.com.au/cooking-vegetables>. In addition, on that page, there are images and instructions for how to steam, stir-fry and oven-bake vegetables, including information on the impact of over-cooking, other cooking methods and canned and frozen vegetables in terms of flavour, texture and nutritional content, plus other cooking tips, such as not to thaw frozen vegetables prior to cooking with them, and to consumer carotenoid-rich vegetables with an oil or fat for maximum pro-Vitamin A absorption.

The Asian Vegetable Case Study

We found very little data on raw Asian vegetables, much less on the impact of cooking on key nutrients. Thus we sourced relevant Asian produce from retail environments, cooked by either steaming, stir-frying, or boiling and obtained analysis via a NATA accredited laboratory for Vitamin C (ascorbic acid), in triplicate. Cooking methods for Asian vegetables were as described in Stephanie Alexander's Cooks Companion and in Charmaine Solomon's Encyclopaedia of Asian cookery; for example stir-frying also involves addition of a small amount of liquid and placing the lid on for 1 – 1.5 mins. Samples were chosen to cover leafy (bok choy, choy sum, Chinese mustard, wombok), stalky green (Chinese cabbage), root (daikon radish) and cucurbit fruit (bitter melon) vegetable types. Also kimchi (pickled cabbage, not cooked). The results are presented in Appendix 2.

Stakeholder & Consumer Understanding

The outputs in terms of diagrams representing different cooking methods, and diagrammatic/photographic means of demonstrating which vegetables to cook which way, how to steam, stir-fry etc., and the instructions for using and cooking with Asian vegetables were tested on 500 consumers representing a cross section of the population who regularly cook via an online survey.

In addition, approximately 80 more aligned stakeholders were assessed using a different online survey, but asking similar questions. The results from these surveys (summarized in Appendix 2) informed amendments to how the information was presented, the final versions of which can be seen at <http://www.veggycation.com.au/cooking-vegetables>.

Outputs

1. The www.veggycation.com.au website has been updated with all the new information, available on a new page <http://www.veggycation.com.au/cooking-vegetables>.



2. The 'What is Veggycation' page has been updated, and both the 'Veg Lovers' and 'For Growers (& Industry)' pages have been updated with a more usable search page for the information, using pictures as active links.

For Veg Lovers

Welcome fellow Veg Lover! In this section of the site, you will find detailed information on the proven health benefits of vegetables. You can search by specific vegetable or by health benefit, and there's plenty of useful advice too.



Vegetables

Eating at least five serves of different vegetables every day is good for your health. Search for the information about specific vegetables by [clicking here](#).



Health Benefits

A diet rich in vegetables (and fruit) reduces the risk of coronary heart disease. Find out what other health benefits vegetables provide by [clicking here](#).



Nutrients

Vegetables are rich in vitamin C, folate, and water. Find out more about specific vitamins and minerals in vegetables by [clicking here](#).



Phytonutrients

Apart from vitamins and minerals, vegetables are also rich in a wide range of phytonutrients (these are the things that give vegetables their colour and/or flavour like lycopene, lutein and beta-carotene). Find out more about vegetable phytonutrients by [clicking here](#).



Serving Size

But what is a serve of veg? Find out how much you need to eat by [clicking here](#).

For Growers (& Industry)



Welcome - In this section of the site, you will find detailed information on the proven health benefits of vegetables. You can search by specific vegetable, or by nutrient or by health benefit, and there's useful advice on vegetable management too. We also provide a guide to making nutrition and health benefit claims and give you links to follow for further information related to health benefits of vegetables.



Vegetables

Eating at least five serves of different vegetables every day is good for your health. Search for the information about specific vegetables by [clicking here](#).



Health Benefits

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Apart from vitamins and minerals, vegetables are also rich in a wide range of phytonutrients (these are the things that give vegetables their colour and flavour like lycopene, lutein and beta-carotene). Find out more about vegetable phytonutrients by [clicking here](#).



Serving Size

What is a serve of veg? Find out how much you need to eat by [clicking here](#).



HOW TO Guide

This downloadable PDF provides a guide to using the searchable Veggycation functions to identify relevant nutrients, develop NIPs and ingredient lists and write health claims for vegetable products. To access the HOW TO guide [click here](#).



10 Step Guide 6-10

This video was filmed at the 2014 Adelaide Grower workshop, and shows Drs Hazel MacTavish-West and Jocelyn Eason explaining the 6/10 Health Claim Messaging. [Click here to download](#).

3. **Recommended** cooking methods and specific information on the impact of cooking on the nutritional content and health benefits of each levied vegetable was summarised (Appendix 1) – also seen at <http://www.veggycation.com.au/for-veg-lovers/vegetables>. This also includes instructions for consuming specific vegetables with an oil or fat, for maximum absorption of nutrients, where applicable. This populates the 'Vegetables' page for each levied vegetable a little like this:



Carrots

Alternative name: None

Scientific name: *Daucus carota*

Serving size: 75 g

Description: Carrots are a root vegetable with most having orange flesh and green leaves. While we usually associate carrots with the colour orange, carrots may be white, yellow, red, or purple. Carrots belong to the Apiaceae family. Carrots are related to parsnips, fennel, parsley, anise, caraway, cumin and dill.

One serve of this vegetable provides a source of the nutrients:

One serve of this vegetable provides a source (10% of the RDI or 2g for fibre) of these nutrients:
Fibre; Potassium; Vitamin B6; Vitamin C; Vitamin K

One serve of this vegetable provides a good source (25% of the RDI or 4g for fibre) of these nutrients:
Vitamin A

Phytonutrients: Beta-carotene; Alpha-carotene; Lutein & zeaxanthin; Flavonols; Flavones; Phenolic acids; Lignans; Coumarins; Polyacetylenes; Lipoic acid; Glutathione; Carotenes; Carotenoids; Luteolin

Health benefits associated with eating a single serve of this vegetable:







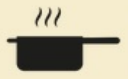

FSANZ have approved this **High level health claim** for all fruit and vegetables:
"A diet containing an increased amount of both fruit and vegetables reduces the risk of coronary heart disease"

And this **General level health claim**, also:
"A diet containing a high amount of fruit and vegetables contributes to heart health"

Preparation & Cooking Tips: There are many benefits from eating both raw and cooked carrots regularly. Peeling doesn't have as big an impact on nutrient loss as with some other vegetables, although in some carrots, especially purple varieties, a reduction in bitterness may be noted with peeling. Carrots are one of the few vegetables that contain a good source level - well over 25% of the RDI per serve - of a vitamin, in this case Vitamin A. Actually, they contain very high levels of orange coloured beta-carotene, which is converted by our bodies into Vitamin A. Whilst some key nutrients may be reduced by cooking, others, such as Vitamin A from beta-carotene, are made more available to our bodies, and Vitamin B6 is retained well with cooking. Addition of fat in the form of butter, or oil, increases our ability to absorb fat-soluble Vitamin A-forming carotenoids. In scientific studies, boiling and other cooking methods reduced Vitamin C content below the 10% RDI per serve, but effectively increased folate to more than 10% of the RDI per serve. Potassium was reduced below 10% of the RDI per serve with boiling and cooking from frozen. Steaming retains more nutrients than boiling and produces tastier carrots. If carrots are cooked whole, then cut up, they are noticeably sweeter than if they are cut up first, as less sugars are lost during the cooking process (especially noticeable with boiling). Carrots are often used in Asian cooking, also. Canned carrots have lost 88% of their Vitamin C, and 26% of their anti-oxidant activity compared with freshly harvested carrots. Frozen carrots lose 10-36% of their carotenoid content, and up to 35% of their Vitamin C content in the blanching process which precedes commercial freezing, although there is some variability in the results from several studies on this subject. We recommend any cooking method for carrots, as the Vitamin-A forming carotenoids are present at such a high level. Try to eat a carrot, every day, for your health. The 'white blush' which sometimes appears on the surface of refrigerated carrots is a harmless discolouration resulting from moisture loss or abrasion during storage. It has nothing to do with chlorine and does not affect the taste or nutritional value of the carrots.










4. **Diagrammatic** representation of different cooking methods were developed and tested on 600 stakeholders and consumers and amended for clarity. These are shown below in their final format, and are also available from <http://www.veggycation.com.au/downloads>.



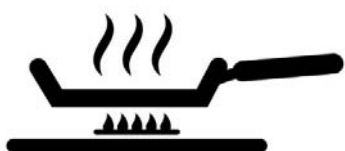
Stir-fry



Steam



Oven bake



Fry



Microwave



Boil




Slow-cook



BBQ

5. **More detailed** information, including images and instructions for how to steam, stir-fry and oven-bake vegetables, plus information on the impact of over-cooking, other cooking methods and canned and frozen vegetables in terms of flavour, texture and nutritional content, plus other cooking tips, such as not to thaw frozen vegetables prior to cooking with them is presented on <http://www.veggycation.com.au/cooking-vegetables>. Images as of 1/12/2014 are displayed below, note that these may update online over coming days.

Cooking Veg




- Steaming vegetables
- Stir-frying vegetables
- Oven-baking vegetables
- Other methods of cooking vegetables
- Recommended cooking methods for vegetables
- Find out about Frozen vegetables
- Find out about Canned vegetables
- Cooking with Asian vegetables

Cooking Recommendations for Optimum Taste & Nutrition

Cooking changes the colour, texture, taste and the nutritional content of vegetables.

- **Colour:** Heat breaks down enzymes and stabilises proteins, making green colours more vibrant
- **Nutrients:** Water leaches out water-soluble vitamins like Vitamins B and C, and water-soluble phytonutrients like the purple colour in purple cabbage, or beetroot. Adding oil to a stir-fry, or dressing, makes fat-soluble vitamins and phytonutrients more easily absorbed by us, like beta-carotene in carrots (which makes Vitamin A in our body)
- **Texture:** The combination of heat and time makes vegetables softer and easier to eat and digest.
- **Flavour:** Flavours change, as some components of fresh, 'green' flavour are lost due to heat, sugars can caramelise (go brown) producing new flavours, or bitter flavours can become more dominant.
- **Over-cooking vegetables:**
 - makes green vegetables go even darker and less vibrant
 - leaches even more nutrients out
 - makes them softer and mushier
 - can remove all the typical flavour that we expect from fresh vegetables.

Chinese broccoli (Gai Lan) prepared for stir-frying





steaming

3 MINS MAX

What: Steaming uses the heat from boiling water vapour to cook vegetables.

How to: You can use a wok and bamboo steamer, an electric steamer, or a steam insert in a pan to steam vegetables.

Timing/Method: After the water starts boiling, add vegetables to the steamer and steam for a maximum of 3 minutes. Longer leads to mushy, limp vegetables, & greater loss of nutrients.

Benefits: Rapid cooking and very low water contact leaves vegetables brightly coloured, crunchy and tasting great, and minimises loss of water soluble vitamins like Vitamin C.

Which vegetables to steam: most vegetables can be cooked by steaming, check out the complete list of vegetables and their optimum cooking methods for best flavour and nutritional content by [clicking here](#).



Bok Choy steamed for 3 minutes in a bamboo steamer and wok, served with a drizzle of oyster sauce and sprinkled with sesame seeds.



Cauliflower and broccoli florets steamed for 3 minutes. Sprinkle with breadcrumbs and grated cheese and place under grill for a few minutes to melt the cheese.



stir-frying

3 MINS MAX

What: Stir-frying uses high contact heat with pan, a small amount of oil, and sometimes a small amount of water to cook vegetables.

How to: You can use a wok or a fry-pan to stir-fry vegetables.

Timing/Method: Heat pan on high, add oil and when hot, add vegetables*. Keep vegetables moving with a heat-proof spatula. Stir-fry for 2 mins, add a small amount (1-2 tablespoons) of water, place lid over wok/pan and leave for 1 min. Cooking time: a maximum of 3 minutes. Longer leads to mushy, limp vegetables, & greater loss of nutrients.

Benefits: Rapid cooking and very low water contact leaves vegetables brightly coloured, crunchy and tasting great, and minimises loss of water soluble vitamins like Vitamin C. The addition of oil makes fat-soluble vitamins and phytonutrients more available to your body.

Which vegetables to stir-fry: many vegetables can be cooked by stir-frying, not just Asian vegetables. Check out the complete list of vegetables and their optimum cooking methods for best flavour and nutritional content by [clicking here](#).



**Prepare vegetables so that they cook in the same amount of time, i.e. chop harder vegetables like carrots into smaller pieces than 'softer' vegetables like green beans or leafy greens. OR, add harder vegetables first, and 'softer' vegetables later in the cooking time.*



oven-baking

What: Oven-baking uses hot air and a small amount of oil to cook vegetables.

How to: You can use a conventional or fan-forced oven, or a combined microwave/oven on oven setting to bake vegetables.

Timing/Method: Prepare vegetables by cutting into large chunks, and toss them in a small amount of oil. For whole baked potatoes, carefully push a metal skewer right through the potato and remove it again, to make a hole for steam to escape. Place veg on oven tray and into oven at 160°C (fan forced) or 180°C until soft (20-45 mins depending on cut size).

Benefits: Oven-baking is great for vegetables like root and starchy vegetables and potatoes, making the energy and fibre available, and caramelising the sugars to make them taste great. Although the heat reduces some vitamins, the lack of water maintains others. The addition of oil makes fat-soluble vitamins and phytonutrients more available to your body.

Which vegetables to oven-bake: Check out the complete list of vegetables and their optimum cooking methods for best flavour and nutritional content by [clicking here](#).

A tray of vegetables ready to oven bake, we added a whole head of garlic sliced in half, and some herbs for flavour.



And now ready to enjoy with roasted meats, or all on their own!

Skewering a potato prior to baking, remove skewer



There are many other ways of cooking vegetables including:



Microwaving: There's not a lot of consistent scientific information on the impact of microwaving on vegetable nutrients. Keep the amount of water and time used minimal.



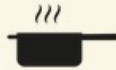
Frying: Keep cooking times short, and minimise the amount of oil added. Drain on paper towel prior to serving.



BBQ'ing: A great way to enjoy vegetables like capsicum, corn and potatoes. Brush with oil and keep cooking times short.



Slow-cooking: Because slow-cookers take a long time, and there is usually a lot of water present, the vegetables end up mushy and over-cooked. However, most of the liquid is generally eaten too, so nutrients can still be OK overall.



Boiling: Although most people still boil vegetables, it's not recommended as a lot of water is used, which leaches water-soluble vitamins, and it's very easy to over-cook boiled vegetables.

A note on washing and peeling vegetables: All vegetables should be washed prior to eating or cooking. Although traditionally many vegetables like carrots, parsnips and potatoes are peeled before cooking, try leaving the peel on. We don't think you'll notice the difference much, and the extra fibre is great for your body. Try things like:

- Oven-baked potato wedges (peel on) instead of chips
- Leave the peel on when steaming potatoes for mash, or potato salad
- Leave the peel on when grating carrots to make coleslaw, or when preparing them for cooking
- Oven bake beetroot with the peel on, then rub (using rubber gloves to stop your hands going pink) the skins off and enjoy hot or cold.



A note on frozen vegetables:

The first step of freezing involves a blanching step, which is effectively a cooking step, thus there is always some loss of nutrients, particularly heat sensitive and water-soluble compounds. Steam blanching is preferable to methods that involve vegetables being immersed in water. Boiling frozen vegetables is particularly detrimental. If using frozen vegetables, it is best to use cooking methods with minimal or no water and keep cooking time to a minimum.

DO NOT thaw frozen vegetables prior to cooking, as this reduces many vitamins dramatically.

- **Vitamin C:** Freezing is better than canning in terms of Vitamin C retention. Nutrient retention in frozen vegetables can be better than fresh veg stored in ambient or refrigerated storage.
- **B vitamins:** The blanch step results in significant losses.
- **Carotenoids (fat-soluble):** Small losses of beta-carotene on cooking frozen broccoli, with microwaving having greatest loss. In frozen red capsicum, boiling caused greatest loss. Losses on blanching and freezing occurred for broccoli (22-48%), carrots (10-36%) and green beans (5%) while for corn it increased. Lycopene relatively stable during processing.
- **Vitamin E (fat-soluble):** Small losses of vitamins on cooking frozen broccoli by boiling, with higher losses in steamed and microwaved. For frozen red capsicum, greatest losses were with steaming and microwaving, and boiling led to a slight increase. Thermal processing may release Vitamin E.
- **Minerals:** Inconsistent results, because levels are so dependent on processing techniques and water mineral content.
- **Anti-oxidant activity:** Cooking frozen vegetables - microwaving resulted in no loss of activity of peas or spinach, short boiling time resulted in a small loss, but overcooking resulted in a significant loss. Many vegetables showed minimal loss of antioxidant activity after 8 months of frozen storage.

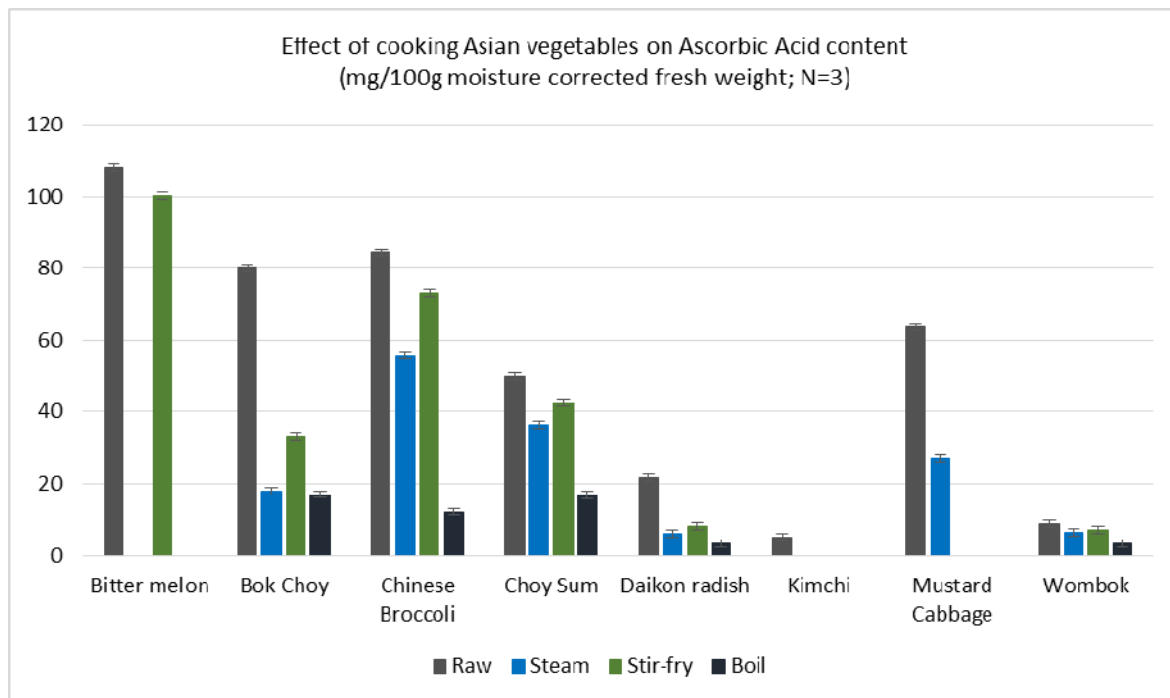


A note on canned vegetables:

Canning is generally more detrimental than freezing in particular for water soluble nutrients because they leach into the canning liquid.

- **Vitamin C:** Major loss with canning - in many cases seems to be proportional to absolute Vitamin C content: the higher the level of Vitamin C, the greater the % loss.
- **B vitamins:** Significant loss of thiamin with thermal processing. Rates of degradation vary between vegetables. Riboflavin generally only small losses. Vitamin B6 loss of 57-77% in many vegetables, but increased in tomato. Niacin is relatively stable, with losses often less than 10%. Folate losses vary from 0 up to 30%. There is loss of folate into the canning liquid.
- **Carotenoids (fat-soluble):** On a wet weight basis there is little or no change in carotenoids (pro Vitamin A), and Lycopene is relatively stable during processing.
- **Vitamin E (fat-soluble):** Thermal processing may release Vitamin E which is still present in canned vegetables, sometimes at higher levels than fresh or frozen, but there are very few studies.
- **Minerals:** Inconsistent results, because these are so dependent on processing techniques and water mineral content.
- **Anti-oxidant activity:** Inconsistent results: In one study, canned vegetables showed a more pronounced loss of activity than frozen compared with fresh. In another, losses were less than for freezing. Canned vegetables showed minimal loss of anti-oxidant activity after 18 months of storage.

6. **Asian Vegetables:** The impact of cooking on the Vitamin C content in different types of Asian vegetables was assayed:



Note:

- The comparatively high levels of ascorbic acid in raw bitter melon, bok choy and chinese broccoli, with much lower levels for daikon radish, wombok and kimchi (pickled cabbage/radish).
- The comparatively higher retention of Ascorbic acid in stir-fried samples of leafy veg and root veg (daikon radish) compared with other cooking methods (steaming and boiling).
- The poor effects from boiling, in all cases.
- 'Stir-frying' in Asian culture generally involves adding veg to a small amount of hot oil and frying with regular movement for 1-2 mins, followed by addition of a small amount of liquid (water or stock), placing the lid on the wok and leaving for 1-2 mins. The liquid is generally so concentrated as a result, that most of it stays with the veg upon serving.
- Bitter melon was only assessed raw, and as a fried sample (fried in oil until slightly golden, 5-6 mins), reflecting normal usage. Ascorbic acid retention was good, however a normally used pre-preparation step of sprinkling salt over and leaving for 15 mins followed by rinsing in water (to reduce bitterness) may reduce ascorbic acid somewhat, and this was not tested, and the level in raw bitter melon was very high to start with.
- Note that challenges were seen regarding retention of Vitamin C in frozen, raw samples illustrated an important aspect for the protocol for sampling: that fresh samples be submitted raw, not frozen. Enzymatic and oxidative breakdown upon thawing rapidly deteriorated Vitamin C levels. This did not occur in frozen samples that had been cooked first, due to enzyme inactivation. **This experiment could be presented as a scientific paper.**

7. **Diagrammatic** and photographic representations of preparation and usage suggestions for **Asian vegetables** in five traditional and more mainstream recipes were developed and tested on almost 600 stakeholders and consumers, and were then amended for clarity. These include:

- ***Kale & Chinese Cabbage Stir-fry***: a European style dish using kale and Chinese cabbage.
- ***Vegetable Fritters***: a European style dish using Daikon radish, zucchini, carrots, spring onions, chilli and eggs.
- ***Asian-style Omelette***: a European style dish, utilising an unusual but valued Asian vegetable: Bitter melon, which has exceedingly high Vitamin C content. Note this method of cooking bitter melon is also used in Asia.
- ***Vegetable & Chicken Stir-fry***: An Asian-style dish, with instructions for preparing and cooking different vegetables for optimum taste and nutrition.
- ***Speedy Vegetable Stir-fry***: An Asian-style dish, with instructions for preparing and cooking different vegetables for optimum taste and nutrition.

These are shown below in their final format. Note pre-agreement not to present these as videos was received from Horticulture Innovation Australia, with recommendations that the final formats we proposed made them more accessible.

In addition, Asian vegetables Bok choy and Chinese broccoli were used to illustrate steaming and stir-frying techniques on the Cooking page. The full copy may be seen in a format easily accessed by iPhones and other media devices at <http://www.veggycation.com.au/cooking-vegetables> and as print-ready A3 documents which may be downloaded from <http://www.veggycation.com.au/downloads>.





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Kale & Chinese Cabbage Stir-fry

SERVES 2-4



1

Tuscan Kale
Chinese cabbage (Wombok)
Baby Kale

Ingredients
½ large bunch Curly or Tuscan Kale, OR 1 large bag of Baby Kale, ¼ Chinese cabbage (also called Wombok, available in most supermarkets), or use other leafy green veg, 1 tbsp olive oil, 2 tsp butter, 1 tsp sesame seeds, pinch of salt (optional)



2

Preparation
Remove thick midribs from Kale, unless using Baby Kale. Slice Cabbage and Kale into 1-2cm widths. Place in a colander and wash under running water, shake off water



3

Cooking
Melt butter and oil in frying pan or Wok. Add all sliced greens and salt, if using. Stir-fry, turning frequently for 2-3 mins.



4

Serving suggestion
Serve with a sprinkle of sesame seeds. Enjoy with sausages, grilled chops or steak.

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For information on the nutritional content and other information on vegetables featured in this recipe, please check out veggycation.com.au



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Vegetable Fritters

SERVES 4



1

Zucchini

Spring of Coriander

White Asian Daikon Radish

Ingredients

1/2 of a White Asian Daikon Radish (from Asian grocers or green grocers), 1 zucchini, 1 carrot, 2-3 spring onions, 1/2 red chili, sprigs of coriander and mint or parsley, 2 eggs, 1/2 cup crispy breadcrumbs, 1/4 cup SR flour, 1 1/2 cup light vegetable oil for frying.



2

Preparation

Peel, if necessary, then grate carrot and Daikon Radish; grate zucchini. Squeeze any excess moisture from grated vegetables. Slice spring onions, chop herbs, de-seed and chop chili finely. Whisk eggs.



3

Preparation

Mix all ingredients together.



4

Cooking

Heat oil in fry-pan, med heat. Drop tablespoons of mixture into oil gently, 3-4 at a time. Fry for 2-3 mins, turn, and cook for 2-3 mins so fritters are firm, and light brown. Drain on kitchen paper.



5

Serving suggestion

Serve immediately. A Yogurt and mint dressing, or sweet chilli sauce goes really well with these.

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For information on the nutritional content and other information on vegetables featured in this recipe, please check out veggycation.com.au



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Asian-style omelette

SERVES 2



Ingredients
1 – 2 Asian gourds, also called Bitter Melon* (from Asian grocers or greengrocers), ½ red chilli, 3 spring onions, 3 eggs, 2-3 tsp salt, ½-1 tbsp canola or rice bran oil.



Preparation
Slice Asian gourd lengthwise in half. Scoop out seeds with a teaspoon, discard seeds. Slice flesh very finely (we used a Mandolin slicer). Sprinkle salt on slices and leave, 15 mins.



Preparation
(Rinse sliced gourd to remove salt, drain and squeeze excess moisture out (this reduces the natural bitterness). Whisk eggs together. Deseed and chop chilli, finely slice spring onions.



Cooking
Heat oil in fry-pan, med heat. Lightly fry sliced gourd for 2-3 mins. Add whisked eggs and cook for 1½ mins with stirring, then allow to set.



Serving suggestion
Serve folded in half with chilli and spring onions sprinkled over, with a leafy salad.

*See "Bitter Melon" on www.veggycation.com.au for more purchase and preparation information.

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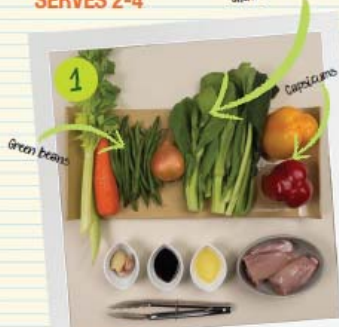
For information on the nutritional content and other information on vegetables featured in this recipe, please check out veggycation.com.au



Vegetable & Chicken Stir-fry

SERVES 2-4

Chinese broccoli (Gai Lan)



Ingredients

A handful each of Chinese broccoli (Gai Lan, available from Asian grocers and greengrocers), and green beans, 1 red and 1 yellow capsicum, 1 carrot, 1 onion, 1-2 sticks of celery, 1 chicken breast or 2 chicken thighs, Small knob of fresh ginger, 1-2 garlic cloves, 1-2 tbsp soy sauce, 1 tbsp oyster or rice bran oil, 1 tbsp cornflour and ¼ cup chicken stock (not shown in pic).

2



Prepare chicken

Peel and slice finely ginger and garlic, mix with soy sauce to make marinade. Slice chicken into 1 cm slices, add marinade and stir. Cover and leave for 10 mins in fridge.

3



Prepare veg

Wash and slice broccoli and beans into 2-3 cm widths diagonally, slice de-seeded capsicums into ½ cm slices. Peel carrot, and slice celery and carrot into ½ cm thick slices diagonally. Slice onion in half, then each half into ½, then break into layers.

4



Cooking

1. Heat oil in wok, med high. Whilst turning ingredients regularly;
2. Add chicken and cook 2-3 mins;
3. Add carrots, cook 1-2 mins;
4. Add all other veg, cook 1-2 mins;
5. Mix cornflour into stock and add to wok, cook 1 min;
6. Stir and serve.

5

Serving suggestion

Sprinkle with chopped coriander and chilli or roasted peanuts or fried shallots and serve with steamed jasmine rice.



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For information on the nutritional content and other information on vegetables featured in this recipe, please check out veggycation.com.au



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Speedy Vegetable Stir-fry

SERVES 2



Ingredients
1 1/2 of a white Asian Dailkon Radish (from Asian grocers or greengrocers), a handful each of bean sprouts, snow peas, mushrooms (we used oyster mushrooms), 2-3 spring onions, 1/2 red chilli, 1-2 garlic cloves, spring of fresh coriander, 1/3 cup vegetable stock, 1 tsp canola or rice bran oil.



Preparation
Wash and slice peas into 2 cm widths diagonally, slice mushrooms 1/2 large, slice spring onions finely. Peel and finely slice dailkon radish. De-seed and slice chilli finely. Crush or slice garlic. Chop coriander.



Cooking
Heat oil in wok. Add garlic, vegetables (not spring onions) and mushrooms. Cook, turning frequently for 1 1/2 mins. Add stock and soy sauce, stir and put lid on. Allow to cook for 1 1/2 mins.



Serving suggestion
Sprinkle with chilli, coriander and spring onions. Serve with honey/soy chicken, or spicy beef, and some steamed jasmine rice.

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For information on the nutritional content and other information on vegetables featured in this recipe, please check out veggycation.com.au

7. **Consumers** (500 people) and stakeholders (approximately 80 people) provided survey feedback on the diagrams of recommended cooking methods (steaming, stir-frying, baking), downloadable pages designed to illustrate 'which vegetables to steam' etc., and 'how to steam vegetables' etc. and preparation and usage suggestions for Asian vegetables in traditional and more mainstream recipes. The feedback is summarised below (more detailed information in Appendix 3), with our responsive actions noted in italics after each note. Note the final versions were presented earlier in this report.

- The diagrams representing 'steaming', 'boiling', 'microwaving' and 'slow cooking' required more work as they were not effective; others were fine. *These diagrams were modified.*
- Diagrammatic/photographic information such as 'which vegetables to steam, or stir-fry' or 'how to steam or stir-fry vegetables', when presented away from the main www.veggycation.com.au website was not clearly understood. Why were we focusing on nutrition and not taste, appearance etc? Respondents wanted more proof that these cooking methods made vegetables look and taste good, plus more images of cooked vegetables. *Instead of being made available as downloads, which have an unclear usage, the 'which veg to steam' and the 'how to steam' (etc.) information has been incorporated onto the website cooking page (<http://www.veggycation.com.au/cooked-vegetables>) as text and images, including images of cooked vegetables; only the cooking diagrams and the Asian vegetable recipes have been made available as downloads. In addition, each levied vegetable now has considerable detail about recommended cooking methods and why.*
- Respondents were unclear why steaming or stir-frying for only 3 minutes was recommended, and they wondered what happens if cooking is prolonged? *This has now been explained more clearly on the website cooking page. Note: 3 minutes was selected as optimum based on textural and flavour changes, and many studies on brassicas and the impact of cooking on glucosinolates. There is insufficient data generally from either USDA or NUTTAB sources, or scientific papers, to conclude an optimum cooking **time**, so we have used general principles, and an understanding that most consumers will not time anything, but they will get the message not to overcook them, and thus get a better nutritional outcome and a better eating experience.*
- When we made recommendations for specific oils for stir-frying, this raised a hornets nest of comments, with dietitians being unhappy about coconut oil being mentioned, and others not understanding why Extra Virgin Olive Oil was not recommended for cooking. *We have deleted this information as it was outwith the scope of the current project anyway. We have continued to make mention of specific relevant cooking oils on the recipes for Asian vegetables.*
- Respondents felt they needed more information on how to prepare vegetables for the recipes, and also that text for instructions was too small. There was feedback about photographic style and layout, and the terms 'bioavailable' and 'brassica' were not well understood by consumers. *Additional information was added to the recipe downloads and online regarding sourcing and preparing the Asian vegetables. Layouts were made to be more in line with the rest of the Veggycation® website and other downloads from previous projects.*

8. Press releases are being developed and will be submitted for approval by HIA, targeted at:

- grower industry journalists/media
- food journalists/media
- health journalists/media
- education journalists/media
- industry (retail, catering) journalists/media

These will outline the Veggycation® project and the additional work on optimal cooking for health, and its support and aims. Plus the relevant outputs for each stakeholder group, and the potential applications for these in terms of educating caterers, parents, chefs, consumers. We will provide this information to stakeholders we have developed working relationships with via our Veggycation® activities, including the Stephanie Alexander Kitchen Garden, dietitians, retailers, growers, and to research providers for other HIA-funded projects of relevance. In addition, we will upload the press releases, once approved, to Newsmodo (www.newsmodo.com), which is a site where professional freelancers receive briefs from publishers, pitch proposals, get commissioned and paid for quality content and coverage. We will monitor the output of press articles, and the rate of downloads from the website, to assess usage for 6 months.

Outcomes

The already rich information source regarding the nutritional quality, health benefits and usability of Australian-grown levied vegetables, available via www.veggycation.com.au, has been significantly increased.

The consumer-friendly nature of the search page under 'Veg Lovers' and 'For Growers (& Industry)' has been improved, making the online experience more streamlined.

A number of quality downloads in the form of diagrams, photos, information and usage suggestions for Asian vegetables have been made available.

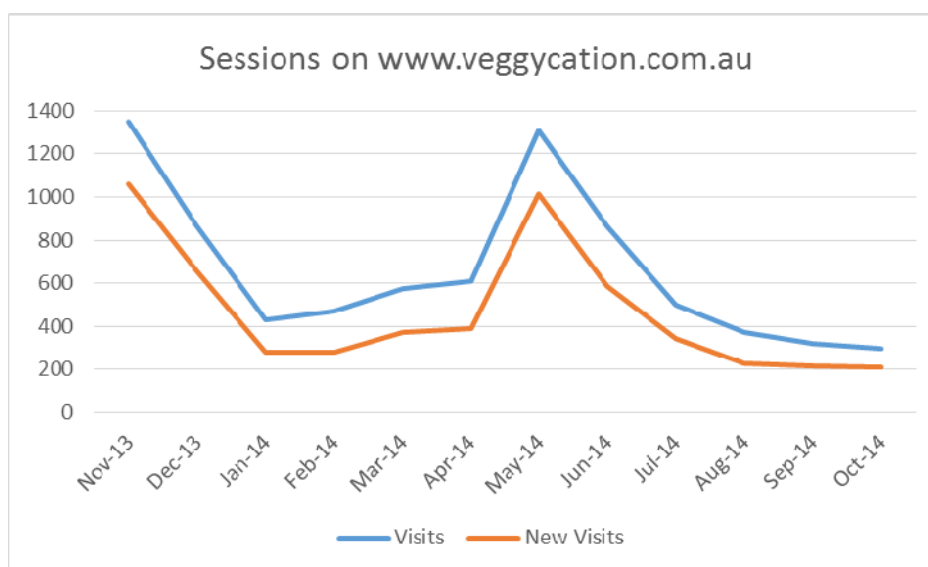
Feedback from diverse stakeholders and consumers has been received and responded to, widening the exposure to Veggycation®.

Release of the press releases and continued monitoring of their uptake will provide even more exposure.



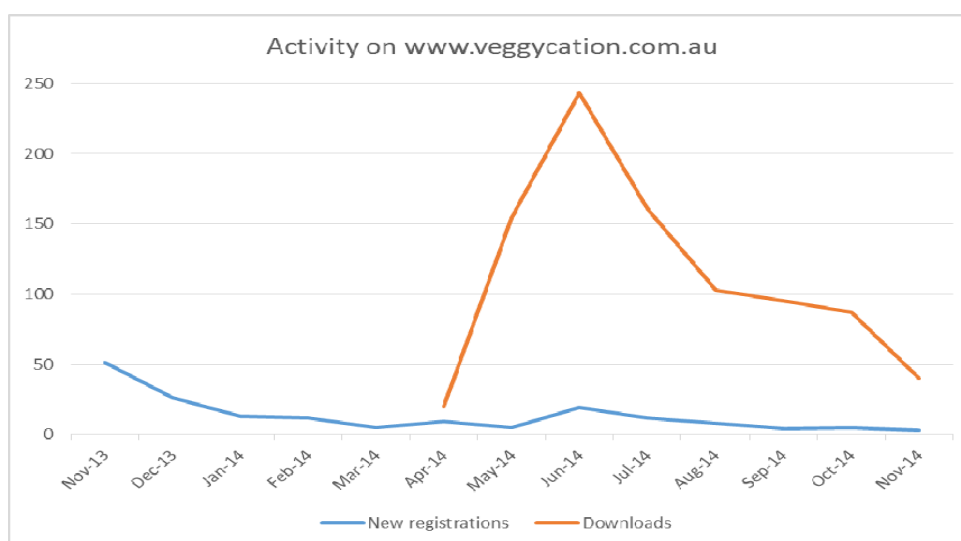
Evaluation and Discussion

www.veggycation.com.au represents a veritable treasure trove of consumer-friendly, vibrant, informative and relevant resources for everyone from kids to vegetable lovers, from teachers to doctors, from dietitians to produce marketers. The proof is in the usage:



Usage is steady, with greater access following exposure events such as workshops; approximately 70% of users each month are new. Page visits per session are approximately 4-5 pages.

The rates of new registrations for the Growers (& Industry) page, and downloads from the website since these were established are presented below. Note that 20 applicants have failed to satisfy the AUSVEG requirements for registration, so far.



Engagement with stakeholders:

We regularly receive emails from dietitians like this:

"I think it is a great start and once more is added, it will be fantastic. It would benefit from some pages for children of different ages and perhaps links to some good apps for kids that also incorporate material that fits with school curriculum would be good as many schools use iPads. I think a tab for people wanted to start a bit of home growing would be good. I am a dietitian so I might register and check out the other pages. This site is a great find." Katrina, dietitian.

Plus those from industry requesting information like this:

"I was wondering where we are at in Australia with making nutritional claims. Has anything changed since the information you gave out at your last sessions? The last our regulatory team had from officials was a large folder with certain nutritional phrases that are acceptable to use. Also: are major retailers accepting overseas data to support nutritional claims or do they want the work to be done in Australia? We have had some challenges finding suitable laboratories to carry out tests for us- could you point us in the right direction should the need arise?" Una Woodhouse, Business Development & Central Queensland Business Manager, Monsanto.

And this:

"I am seeking permission to provide a link to Veggycation for Kids via the Love my Salad website. Is this possible please? Thank you". Frances Tolson, Product Development Manager Rijkzwaan.

Providing more information on cooking and usage of vegetables makes them more accessible, and provides resources for teachers, media and others to use to communicate to others.

Recommendations

We believe the industry should continue to provide specific information which today's consumers can seek out and use to answer the question "Why eat vegetables?" To this end, we recommend ongoing management of the Veggycation® website, and extension activities that will continue to educate and promote the nutrition and health benefit messages of vegetables:

1. **Veggycation® website management.** The website needs to be maintained:

- Enabling new registrants, perhaps with a HIA-approved positive list so that responses can be almost immediate (i.e. if registrant resides in Australia) and responding to contact – on a daily basis. Currently, feedback to us for approval of registrants can take days, and even weeks; staff changes at AUSVEG mean the logic behind rejections also changes i.e. teachers and dietitians were initially accepted for the 'Growers (& Industry)' page, but are now not.
- Keeping the technical aspects of the website fresh and up to date, i.e. the way information is downloaded and held in the user's computer, for more rapid upload when re-accessed – annually. We can provide more detail on this upon request.
- Improving and extending links to other valid information sources and HIA-funded nutrition and health media, reports, projects – on a bi-monthly basis.
- The scientific database needs to be updated to keep abreast of new pre-approved FSANZ claims, and new vegetable composition data – annually.
- We recommend extending the database to include a wider range of vegetables that consumers are eating – annually.
- Updating from resources from other, related HIA & Vegetable industry projects, to provide a greater wealth of information for stakeholders – half-yearly.

2. **Actively educating consumers**

- Veggycation® as a branded activity is suitable for promoting increased consumption of vegetables to raise the profile and value of vegetables as part of a healthy diet. This could be extended much further than is currently envisaged via in-store information and on-pack promotions.
- We suggest continued activity and communication with groups such as Nutrition Australia, Dietitians, the Stephanie Alexander Kitchen Garden Foundation, Healthy Children Initiative, etc. to develop more targeted resources for specific demographics, e.g. pre-school children, the elderly.

3. **Positively leveraging all HIA-funded nutrition and health work**

- Active engagement with related HIA projects will ensure the wealth of resources that is being developed for and by the vegetable industry in the nutrition and health space are linked and leveraged for maximum effect. It is critical to ensure we are not distributing

conflicting messages to the key stakeholders. Agreeing on one portal for their communication to stakeholders could also be useful, and www.veggycation.com.au is the obvious choice.

4. **Vegetable recipe development – cooked and fresh**

- Following on from the Asian vegetable case study, and subject to positive responses, we recommend widening the range of preparation, usage and recipe suggestions available via the website.
- Addition of complete nutritional analysis and links with associated health claims would also be valued.

Scientific Refereed Publications

None to report.

IP/Commercialisation

All Intellectual Property rests with HIA. All the outcomes from this work have already been made available on the www.veggycation.com.au website and are freely available either for consumers to access, or for growers & industry, via the registration-only, Login part of the website.

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Appendices

Appendix 1. Table of recommended cooking methods; this and more information may be seen via the dynamic content populated from a search for a specific levied vegetable at www.veggycation.com.au/for-veg-lovers/vegetables. When this information is portrayed, it will be using icons which will either show, or not show, for each levied vegetable.

Common name	Steam	Stir-fry	Bake	BBQ	Boil	Microwave	Any method
Artichokes, Globe	yes	no	no	no	no	no	no
Artichokes, Jerusalem	yes	yes	yes	no	no	no	no
Asparagus	yes	yes	no	yes	no	no	no
Basil	no	no	no	no	no	no	no
Beans, broad	yes	yes	yes	yes	yes	no	yes
Beans, butter	yes	yes	no	no	no	no	no
Beans, green	yes	yes	no	no	no	no	no
Beetroot	yes	yes	yes	yes	no	no	no
Bitter melon	yes	yes	no	no	no	no	no
Bok Choy	no	yes	no	no	no	no	no
Broccoli	yes	yes	no	no	no	no	no
Broccoli, Chinese	yes	yes	no	no	no	no	no
Brussels Sprouts	yes	yes	no	no	no	no	no
Cabbage, Chinese	yes	yes	no	no	no	no	no
Cabbage, mustard	yes	yes	no	no	no	no	no
Cabbage, red	yes	yes	no	no	no	no	no
Cabbage, Savoy	yes	yes	no	no	no	no	no
Cabbage, white or green	yes	yes	no	no	no	no	no
Capsicum, green	no	yes	no	no	no	yes	no
Capsicum, red	no	yes	yes	yes	no	no	yes

Carrots	yes	yes	yes	yes	yes	yes	yes
Carrots, baby	yes	yes	yes	yes	yes	yes	yes
Cassava	yes	no	yes	no	yes	no	no
Cauliflower	yes	yes	yes	yes	no	yes	no
Celeriac	yes	yes	yes	no	no	yes	no
Celery	yes	yes	no	no	no	no	no
Chicory	yes	yes	yes	yes	no	no	no
Chillies, green	no	yes	no	no	no	no	no
Chillies, red	no	yes	no	no	no	no	no
Chives	no	no	no	no	no	no	no
Choy Sum	yes	yes	no	no	no	no	no
Choko	yes	yes	no	no	no	no	no
Coriander, leaves	no	no	no	no	no	no	no
Cucumber, apple	no	yes	no	no	no	yes	no
Cucumber, common	no	yes	no	no	no	yes	no
Cucumber, Lebanese	no	yes	no	no	no	yes	no
Cucumber, telegraph	no	yes	no	no	no	yes	no
Daikon	no	yes	no	no	no	no	no
Eggplant	no	no	yes	yes	no	no	no
Endive	no	no	no	no	no	no	no
Fennel	no	yes	yes	yes	no	yes	no
Garlic	no	yes	yes	yes	no	no	no
Ginger	no	yes	no	no	no	no	no
Kale	yes	yes	yes	no	no	yes	no
Kohlrabi	yes	yes	no	no	no	no	no
Leeks	yes	yes	yes	yes	no	yes	no
Lettuce	yes	yes	no	no	no	no	no
Lettuce, butterhead	yes	yes	no	no	no	no	no
Lettuce, Cos	yes	yes	no	no	no	no	no
Lettuce, iceberg	yes	yes	no	no	no	no	no
Okra	yes	yes	yes	no	no	no	no
Onions	no	yes	yes	yes	no	no	no
Parsley, continental	no	no	no	no	no	no	no
Parsley, curly	no	no	no	no	no	no	no

Parsnips	yes	yes	yes	no	no	yes	no
Peas, green	yes	yes	no	no	no	yes	no
Peas, snow (pod)	yes	yes	no	no	no	yes	no
Potatoes	yes	yes	yes	yes	no	yes	no
Pumpkin	yes	yes	yes	yes	no	yes	no
Pumpkin, butternut	yes	yes	yes	yes	no	yes	no
Pumpkin, golden nugget	yes	yes	yes	yes	no	yes	no
Pumpkin, Jarrahdale	yes	yes	yes	yes	no	yes	no
Pumpkin, Queensland blue	yes	yes	yes	yes	no	yes	no
Radish, red	yes	yes	no	no	no	no	no
Radish, white	yes	yes	no	no	no	no	no
Radicchio	yes	yes	no	yes	no	no	no
Rhubarb	yes	no	yes	no	no	yes	no
Rocket	no	yes	no	no	no	no	no
Shallots	no	yes	yes	yes	no	no	no
Silverbeet	yes	yes	no	no	no	yes	no
Spinach	yes	yes	no	no	no	no	no
Spinach, water	yes	yes	yes	no	no	no	no
Spring Onions	no	yes	yes	no	no	no	no
Sprouts, alfalfa	no	no	no	no	no	no	no
Sprouts, bean	yes	yes	no	no	no	yes	no
Squash, button	yes	yes	no	yes	no	yes	no
Squash, scallopini	yes	yes	no	yes	no	yes	no
Swede	yes	yes	yes	yes	yes	yes	yes
Sweetcorn	yes	yes	yes	yes	yes	yes	yes
Sweet potato	yes	yes	yes	yes	yes	yes	yes
Taro	yes	yes	yes	yes	yes	yes	yes
Tomatoes, cherry	no	yes	yes	yes	no	no	no
Tomatoes, standard red	no	yes	yes	yes	no	no	no

Turnip	yes	yes	no	no	no	yes	no
Water chestnut	yes	yes	no	no	no	no	no
Watercress	yes	yes	no	no	no	no	no
Zucchini, gold	yes	yes	yes	yes	no	yes	no
Zucchini, green	yes	yes	yes	yes	no	yes	no

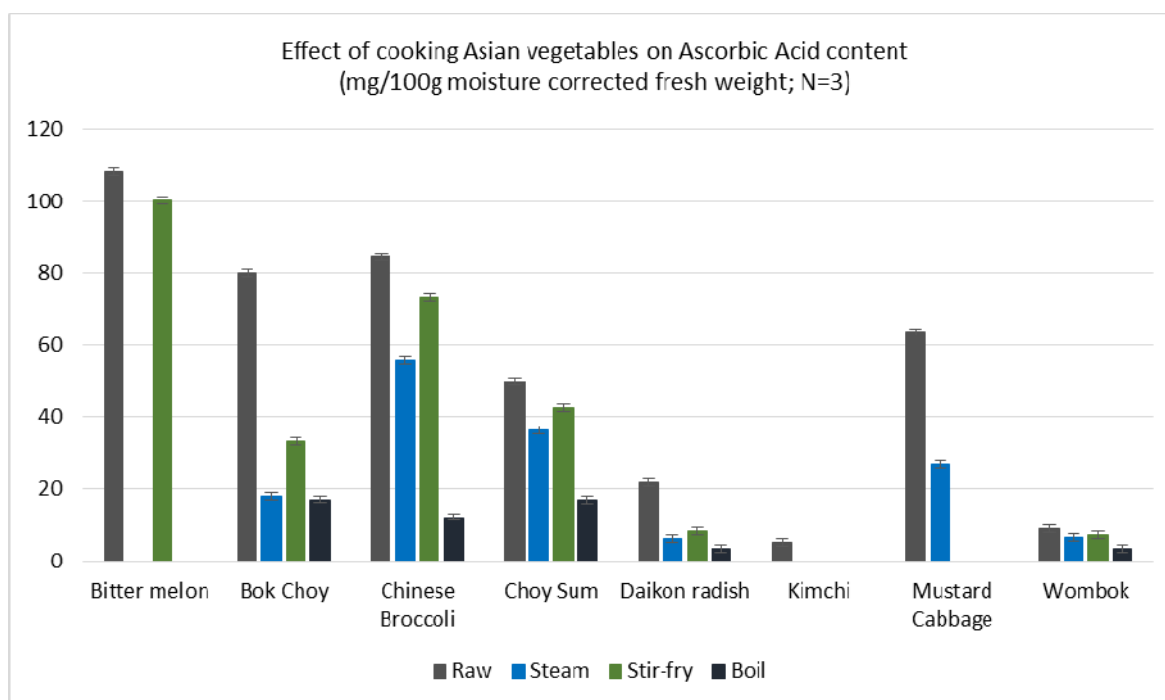
Appendix 2. Asian Vegetable Cooking Study.

We found very little data on raw Asian vegetables, much less on the impact of cooking on key nutrients. Thus we obtained our own analysis of relevant Asian produce sourced from retail environments at a NATA accredited laboratory for Vitamin C. The first tranche of results had unduly low ascorbic acid levels in raw samples. We questioned the lab, and they agreed to repeat the trial using **fresh** raw samples instead of frozen. Ascorbic acid is rapidly degraded upon thawing, and thus protocols for submitting samples to labs for analysis will be reviewed (see also www.foodstandards.gov.au/science/monitoringnutrients/ausnut/foodnutrient/Pages/potato.aspx). Cooking methods for Asian veg were as described in Stephanie Alexander's Cooks Companion and in Charmaine Solomon's Encyclopaedia of Asian cookery.

Samples were chosen to cover leafy (bok choy, choy sum, Chinese mustard, wombok), stalky green (Chinese cabbage), root (daikon radish) and cucurbit fruit (bitter melon) vegetable types. Analysis by National Measurement Institute using accredited methods. Samples prepared and analysed in triplicate.

Results:

	Ascorbic acid (mg/100g moisture corrected fresh weight; N=3)							
Sample	Raw	std dev	Steam	std dev	Stir-fry	std dev	Boil	std dev
Bitter melon	108.12	3.78			100.15	10.66		
Bok Choy	80.04	1.85	17.94	3.29	33.22	4.94	17.04	2.82
Chinese Broccoli	84.45	8.41	55.87	8.06	73.20	7.18	12.18	1.11
Choy Sum	49.78	2.16	36.25	1.07	42.49	5.08	17.00	2.62
Daikon radish	21.68	0.62	6.10	0.39	8.19	0.11	3.46	0.24
Kimchi	5.02							
Mustard Cabbage	63.59	0.62	26.82					
Wombok	8.86	0.24	6.36	0.87	7.16	0.34	3.27	0.61



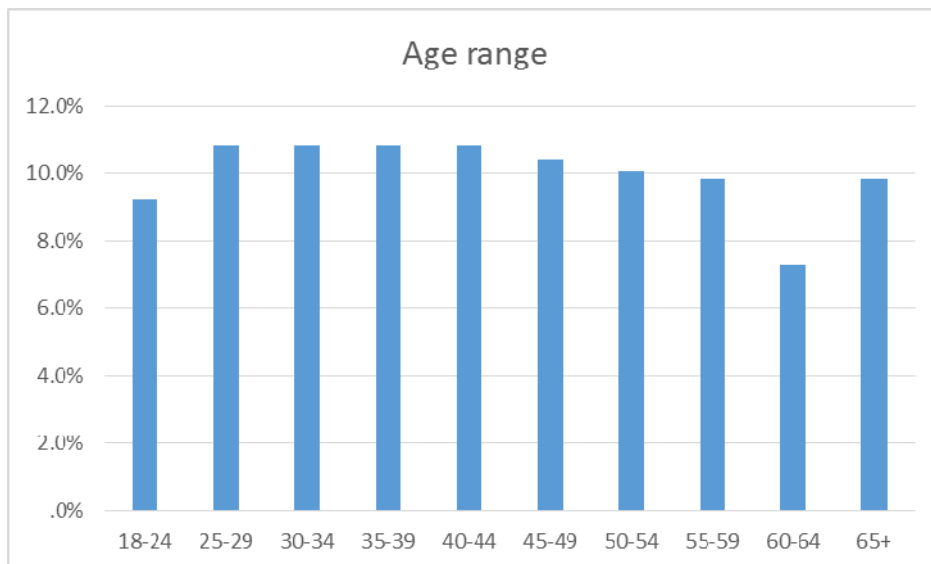
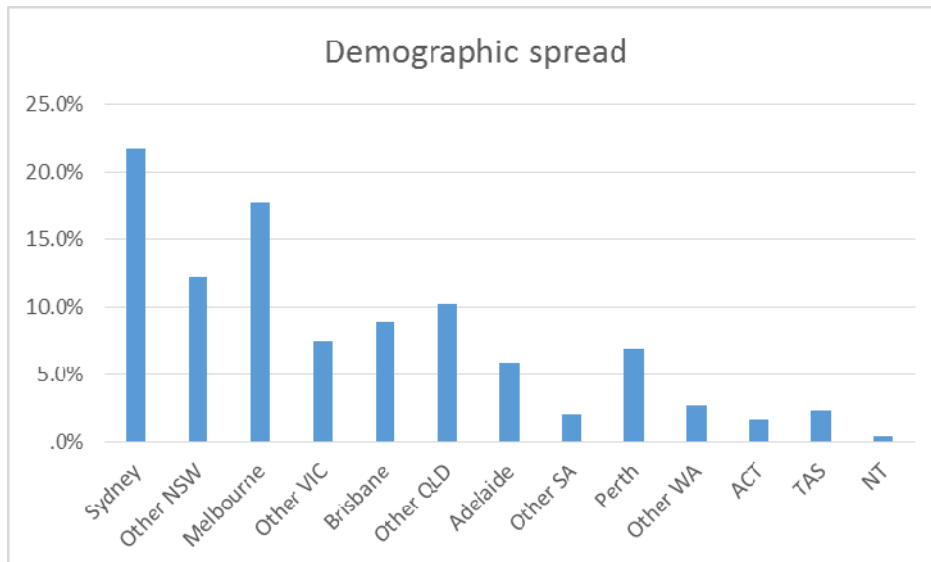
Comment: The comparatively high levels of ascorbic acid in bitter melon, bok choy and chinese broccoli are noted, with much lower levels for daikon radish, wombok and kimchi (pickled cabbage/radish). The comparatively higher retention of Ascorbic acid in **stir-fried samples** of leafy veg and root veg (daikon radish) compared with other cooking methods (steaming and boiling) is noted. Note that 'stir-frying' in Asian culture generally involves adding veg to hot oil and frying with regular stirring for 1-2 mins, followed by addition of a small amount of liquid (water or stock), placing the lid on the wok and leaving for 1-2 mins. The liquid is generally so concentrated as a result, that most of it stays with the veg upon serving. Bitter melon was only assessed raw, and as a fried sample (fried in oil until slightly golden, 5-6 mins). Ascorbic acid retention was good, however a normally used pre-preparation step of sprinkling salt over and leaving for 15 mins followed by rinsing in water (to reduce bitterness) may reduce ascorbic acid somewhat, and this was not tested. It is possible that this experiment can be written up as a scientific paper, when complete.

Appendix 3. Summary of Consumer and Stakeholder Surveys.

Two surveys were undertaken to provide feedback on clarity and understanding of cooking diagrams, and other cooking information.

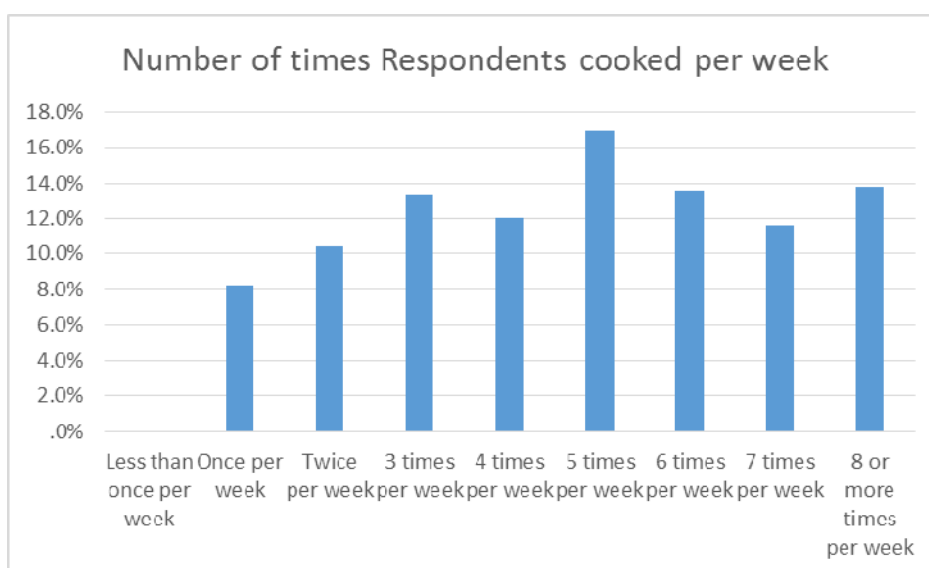
1) A survey of 500 consumers via Nine Rewards, with questions supplied by our team:

a. 51% male, 49% female, good age range:



b. 79.5% were born in Australia; 7.7% were born in Asia.

c. All respondents did some, most or all of the cooking in the household, with people who did no cooking 'bumped' from the survey and not counted in the totals:



d. Results of questions re effectiveness of cooking diagrams:

EFFICACY OF IMAGE - STIR FRY	Very effective	57.1%
	Effective	36.2%
	Not effective	6.7%
EFFICACY OF IMAGE - STEAM	Very effective	29.7%
	Effective	46.7%
	Not effective	23.6%
EFFICACY OF IMAGE - OVEN BAKE	Very effective	54.7%
	Effective	38.8%
	Not effective	6.5%
EFFICACY OF IMAGE - FRY	Very effective	60.6%
	Effective	32.9%
	Not effective	6.5%
EFFICACY OF IMAGE - MICROWAVE	Very effective	54.3%
	Effective	32.3%
	Not effective	13.4%
EFFICACY OF IMAGE - BOIL	Very effective	18.1%
	Effective	41.9%
	Not effective	40.0%
EFFICACY OF IMAGE - SLOW COOK	Very effective	21.5%
	Effective	38.8%
	Not effective	39.8%
EFFICACY OF IMAGE - BBQ	Very effective	70.9%
	Effective	26.0%
	Not effective	3.1%

- e. Responses to other questions about various resources, some of which were subsequently developed entirely differently. Those marked with an * we felt warranted extra explanation or reworking, and this was undertaken.

Some vegetables are best cooked by steaming.	This was clearly explained	85.2%
	This was NOT clearly explained	14.8%
Steaming best preserves nutritional and taste qualities of some vegetables.	This was clearly explained	83.7%
	This was NOT clearly explained	16.3%
Vegetables are best when steamed for 3 mins only.	This was clearly explained	90.4%
	This was NOT clearly explained	9.6%
Steaming preserves water soluble nutrients well.	This was clearly explained	88.2%
	This was NOT clearly explained	11.8%
Steamed vegetables look and taste good.	This was clearly explained	79.1%
	This was NOT clearly explained	20.9%*
Leafy greens, like cabbage, kale and broccoli, are best steamed.	This was clearly explained	82.1%
	This was NOT clearly explained	17.9%
Some vegetables are best cooked by stir-frying	This was clearly explained	84.4%
	This was NOT clearly explained	15.6%
Stir-frying best preserves nutritional and taste qualities of some vegetables.	This was clearly explained	78.3%
	This was NOT clearly explained	21.7%*
Vegetables are best when stir-fried for 3 mins only.	This was clearly explained	70.5%
	This was NOT clearly explained	29.5%*
Some cooking oils are better than others for stir-frying	This was clearly explained	90.2%

vegetables.	This was NOT clearly explained	9.8%
Stir-fried vegetables look and taste good.	This was clearly explained	82.7%
	This was NOT clearly explained	17.3%
Broccoli, bean sprouts and baby spinach are best stir-fried.	This was clearly explained	85.6%
	This was NOT clearly explained	14.4%
Some vegetables can be cooked using a wide range of cooking methods to preserve nutritional and taste qualities.	This was clearly explained	86.6%
	This was NOT clearly explained	13.4%
Carrots, beetroot and onion may be cooked using a wide range of cooking methods for optimum health and nutrition.	This was clearly explained	88.8%
	This was NOT clearly explained	11.2%
Some vegetables can be cooked in many ways because the level of nutrients doesn't get reduced below 10% of the RDI by cooking.	This was clearly explained	88.4%
	This was NOT clearly explained	11.6%
Some vegetables don't contain nutrients at levels above 10% of the RDI to start with.	This was clearly explained	84.4%
	This was NOT clearly explained	15.6%
Cooking with oil makes fat-soluble vitamins more bioavailable.	This was clearly explained	55.5%
	This was NOT clearly explained	44.5%*
Boiling is not advised for any vegetables.	This was clearly explained	83.3%
	This was NOT clearly explained	16.7%
Leaving the skin on vegetables has benefits.	This was clearly explained	90.4%
	This was NOT clearly explained	9.6%
I understand what ingredients and equipment I would need to make this recipe	Yes	96.1%
	No	3.9%

It is clear to me how to prepare the vegetables and other ingredients to make this recipe	Yes	95.7%
	No	4.3%
I would need more information to be able to prepare these ingredients	Yes	39.4%
	No	60.6%*
It is clear to me how to cook this recipe	Yes	95.5%
	No	4.5%
I would like to try this recipe	Yes	81.3%
	No	18.7%
If I cooked and ate a serve of this recipe, there would be benefits to my health, due to the nutrients in the vegetables and other ingredients.	True	91.1%
	False	8.9%

f. Detailed comments were received to most questions, and are available upon request.

2) **The other stakeholder survey** was done online via <https://www.surveymonkey.com/s/VegetableCooking4Health>. This was sent to stakeholders such as participants in previous Veggycation® workshops, HIA and AUSVEG, PMA and dietitians etc. All of the potential recipes were added to this survey, but the earlier questions were the same as the Nine Rewards Survey.

- a. 78 responses were received.
- b. 56% had previously checked out www.veggycation.com.au
- c. Demographic information:

As a stakeholder interested in promoting vegetable consumption, which group do you represent primarily?		
Answer Options	Response Percent	Response Count
Industry (Grower)	7.7%	6
Industry Body/Representative	6.4%	5
Funding Body	2.6%	2
Government	5.1%	4
Educator - children	7.7%	6
Food writer	3.8%	3
Chef* despite many attempts	0.0%	0
Media	6.4%	5
Community	9.0%	7
Retailer	5.1%	4
Wholesaler	1.3%	1
Grower Association	1.3%	1
Public Health	10.3%	8

Academic - research and higher education	14.1%	11
Market analysis	0.0%	0
Consumer	17.9%	14
Consultant	5.1%	4
Food Service	3.8%	3
Restaurateur	0.0%	0
Other (please specify)	11.5%	9
answered question		78
skipped question		0

d. Other specific questions:

What approaches do you think are important to increase vegetable consumption in Australia?		
Answer Options	Response Percent	Response Count
Packaging - improve	11.5%	9
Price	44.9%	35
Availability of vegetables	43.6%	34
More information about growers/growing	29.5%	23
Community activities such as gardens and cooking demonstrations	43.6%	34
Recipes	46.2%	36
In-school vegetable growing clubs	53.8%	42
Government support	20.5%	16
Advertising	34.6%	27
Improved quality	24.4%	19
Improved convenience	30.8%	24
Other (please specify)	17.9%	14
answered question		78
skipped question		0

- e. 71.8% of respondents felt that if the impact of cooking on nutrition and taste of vegetables is made more available to the wider community, vegetable consumption will increase. 28.2% felt it wouldn't.
- f. Results for clarity of cooking diagrams were very similar to Nine Rewards results.
- g. Comments made about the draft layout were revealing; a typical example was this text analysis of the comments for the 'which vegetables to oven bake' page (where larger, bolder words are repeated more often):

Background Dark Easy to
Understand Equipment Explain Images Max
Info Oil Pictures Reading the
Small Stir Text Vegetables Vitamins

h. And this for the page about which vegetables could be cooked in any way:

Bother Reading Complex Contrast High in Sat
Fat Literacy Mention Nutrients Pictures RDI
Text Veg Vegetables
Cooking Words

- i. Feedback on the Bitter melon preparation instructions and recipe was that the name was not appealing, and thus we have changed this to 'Asian-style Omelette'. Although several people questioned why we were bothering with this 'ridiculous' vegetable: which perhaps illustrates the need!
- j. Generally feedback was related to people either liking or hating the way we laid the pictures out, the smallness of the fonts used for some information, and the darkness of the backgrounds. This was amended in the final layouts suggested.
- k. The other feedback was that detailed nutritional analysis of the recipes would be of interest, however this was felt to be over and above the scope of the current project, given that nutritional information about non-vegetables represented some of the information required. But it does represent an interest, and more and more recipe books are listing this information.

End.